A Canonical Correlation Analysis of the MMPI-2 and MCMI-III

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Abstract

The extant literature includes no canonical correlation analyses examining the relationship between the basic MMPI-2 scales and scales on the MCMI-III despite these measures representing two of the most commonly administered tests of personality. The following study was designed to remedy this gap in the literature for the purpose of fostering understanding of the underlying dimensions shared by these measures. Results revealed a statistically significant model based on ten pairs of discriminant functions. A very large effect size was observed in the present study, indicating that the MMPI-2 and MCMI-III shared 97.5% of their variance. Clinical and theoretical conceptualization of the discriminant functions was elaborated and future research suggested.

Keywords: MMPI-2; MCMI-III; personality; personality assessment; personality disorder

The Minnesota Multiphasic Personality Inventory-2 (MMPI-2; Butcher et al., 2001) is the most commonly administered self-report measure of personality and psychological disorders (Camara, Nathan, & Puente, 2000) and consists of 567 dichotomous (true/false) items. The MMPI-2 was normed using a diverse community sample, and is intended to be used with clinical populations, ages 18 and over. Hundreds of studies supporting the psychometric properties of the MMPI-2 appear in the literature (e.g., Butcher & Williams, 2000; Graham, 2006; Greene, 2000). Perhaps the most commonly noted limitation associated with the measure is that most items contribute to several scales, thus fostering heterogeneity and conceptual overlap (e.g., Butcher, Dahlstrom, Graham, Tellegen, & Kaemmer, 1989; Butcher et al., 2001).

In contrast, the Millon Clinical Multiaxial Inventory-III (MCMI-III; Millon, 1994) was developed in a manner to maximally distinguish constructs. The MCMI-III was designed to measure personality disorders as conceptualized by the DSM-IV and reflects its multiaxial format, conceptual terminology, and diagnostic criteria. A relatively brief self-report inventory, it consists of 175 items which are also responded to dichotomously (true/false). This measure was developed and standardized specifically for use with clinical populations (i.e., patients in psychiatric hospitals or people with existing mental health problems), and is appropriate for adults 18 and over. The psychometric properties of the measure have been extensively examined and found to be robust (Millon, 1994; Millon, 1997) and it is reported to be the second most commonly administered personality test (Piotrowski, 1997). A primary weakness often cited in the literature is its weak convergent validity across most of its scales (e.g., Craig, 2005; Strack, 2002).

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As the MMPI-2 and the MCMI-III are among the two most widely administered self-report measures of personality, it is important to understand the relationship between them. Overlap between earlier editions of the MCMI and the MMPI-2 have been reported (e.g., Blais, 1994; Sinha & Watson, 2001; Ward, 1995), and there have been some investigations into whether MMPI-2 scales can predict MCMI-II scales (e.g., Jones, 2005). However, the present applicability of these findings are limited by their focus on older editions of the MCMI (e.g., Jones, 2005), which contain significantly different item composition and psychometric properties (Millon, 1994, 1997). Moreover, previous investigations are limited by their reliance on bivariate correlations, which incorrectly treat an individual's score on a clinical index as independent of their responses on other indices. Thus, the literature would benefit from research focusing on the multivariate relationships between these measures, allowing researchers to understand an individual's personality characteristics in the context of their unique pattern of scores.

The current study was designed to overcome these limitations by investigating how the basic scales of the MMPI-2 relate multivariately to the personality scales of the MCMI-III. We accomplished this goal by employing canonical correlation analysis (CANONA), which was first introduced by Hotelling in 1935, to model the multivariate relationships between the two sets of personality scales (see Tabachnick & Fidell, 2006 for a good overview of CANONA). In stark contrast to the common bivariate approaches comparing the scales on the MMPI-2 and MCMI-III (i.e., separately comparing each scale of the MMPI-2 to each scale of the MCMI-III), CANONA compares *linear combinations* of each measure's scales to one another. Moreover, the psychological meaning of these linear combinations can be investigated using the techniques outlined by Harris (1985, 2001). This approach is conceptually consistent with the clinical use of each measure which relies heavily upon interpreting not single scale scores but patterns of scores in the process of diagnosis. The addition of such multivariate analyses to the literature is necessary for helping researchers identify patterns of personality traits and obtain a better understanding of how certain personality dimensions cluster together.

We hypothesize that the MCMI-III and MMPI-2 will prove to share a significant amount of variance based on the CANONA conducted. An additional hypothesis proposed is that personality clusters will emerge using scales with shared variance on both measures. Finally, considering the previously mentioned limitation of the MMPI-2 as having items that contribute to multiple scales, we expect to find the presence of within-measure correlations.

Method

This study was conducted at an upper Midwestern public university, recruiting the sample from the psychology department recruitment pool. Participants were offered extra credit in their coursework for participating. Procedures included counterbalanced administration of the computer scored MCMI-III and MMPI-2 to prevent an order effect. Data represent 98 adults who completed the MCMI-III and MMPI-2 via paper and pencil in a single session and obtained at least one clinically elevated score on a personality disorder scale of the MCMI-III (i.e., a base rate score of 75 or more). Participants that did not meet this criterion were removed from the analysis as they were not appropriate for hypothesis testing. In order to prevent fatigue, breaks were offered so participants could self-pace; however, no fatigue was reported and no participants discontinued the study. This population may be resilient to long multiple choice measures due to their exposure to similar conditions in the classroom. Participants ranged in age from 18 to 54 years of age, with the most falling in the range of 18 to 24 years (89.8%). The majority of the sample was single (93.9%), female (78.6%), and Caucasian (89.8%; 4.1% Asian; 2.0% African-American, 2.0% Hispanic; and 2.0% unidentified). All participants and their data were treated in accordance with the "Ethical Principles of Psychologists and Code of Conduct" (American Psychological Association, 2002) and this study was approved by the Institutional Review Board.

Results

Statistical analyses were performed with the statistical program SPSS. A canonical correlation analysis (CANONA) was conducted using the ten clinical scales from the MMPI-2 as predictors of the 14 personality disorder scales on the MCMI-III. Evaluation of the linearity, homoscedasticity, low multicollinearity, and normality assumptions underlying CANONA did not reveal any anomalies, and the *a priori* level of significance was set at .05.

The analysis yielded 10 pairs of discriminant functions with squared canonical correlations (R_c^2) of .77, .49, .35, .34, .25, .15, .12, .07, .04, and .03, respectively. A "discriminant function" is a linear combination of scale scores for either the MMPI-2 or MCMI-III that appears as a regression equation in which the scores are weighted and summed into a *multivariate composite*. The squared canonical correlation values represent the proportion of overlap between pairs of such composites, and in CANONA they are successively computed so that they are independent of one another and R_c^2 is maximized. The values for R_c^2 therefore decrease in magnitude from the first function to the last.

The full model, based on all 10 pairs of discriminant functions, was statistically significant according to Wilks' $\lambda = .03$, $F(140, 624.42) = 2.55$, $p < .001$. Because Wilks' λ represents the variance unexplained by the

model, $1 - \lambda$ yields the full model effect size in an r2 metric. Thus, for the set of 10 canonical functions, the effect size was .98, indicating the two measures shared 97.5% of their variance. As an omnibus test, Wilks' λ is not amenable to testing and interpreting the individual canonical functions. Instead, an approach developed by Harris (1985, 2001), and more recently demonstrated by Grice and Iwasaki (2007) in the context of multivariate analysis of variance, must be used.

Harris' approach begins by testing each of pair of multivariate composites for statistical significance using Roy's greatest characteristic root (g.c.r.). For the current data, the result was significant at the .05 level for the first (Theta = .77, s = 10, m = 1.5, n = 36, $p < .001$) and second (Theta = .49, s = 9, m = 1.5, n = 36, $p < .001$) pairs of functions. Theta corresponds to R_c^2 and indicates the proportion of shared variance between the multivariate composites for the MMPI-2 and MCMI-III scale scores; and s, m, and n represent degrees of freedom parameters for the g.c.r. distribution under the null hypothesis. The remaining pairs of functions were not statistically significant.

Table 1 presents the standardized canonical function coefficients and structure coefficients for the two significant pairs of composites. The former values represent the regression weights used to create the multivariate composites, and the latter values represent the bivariate correlations between the individual scale scores and the composites. From Harris' perspective the standardized canonical function coefficients are most useful in determining which variables are important for computing the multivariate composites. The second step is therefore to simplify and interpret the theoretical meaning of each pair of functions based on these coefficients. The coefficients are examined with respect to their relative absolute magnitudes, and a salience criterion is determined. This process is similar to the procedures used to identify salient items from the results of a common factor analysis.

Examination of the coefficients for the first pair of functions revealed clear points of discrimination among the MMPI-2 and MCMI-III scales; namely, high levels of social introversion with avoidant personality characteristics and low histrionic personality characteristics. Following the simplification process employed in factor analysis and scale construction, the most extreme coefficients were replaced with values of -1 or +1 in accord with their signs. The remaining small coefficients were replaced with zeros, yielding the following simplified composite equation relating the MMPI-2 and MCMI-III scales: (1)(Social Introversion) = (1)(Avoidant) + (-1)(Histrionic) or (-1)(Social Introversion) = (-1)(Avoidant) + (1)(Histrionic). Conceptually, this combination of traits represents something akin to a personality type that falls near the extreme poles of the extraversion/introversion continuum. Following the final step in Harris' procedure, the squared correlation between Social Introversion and the linear combination of Histrionic and Avoidant scales was computed and found to be large and statistically significant, R_c^2 (98) = .58, $p < .001$. This large effect indicates that the MMPI-2 Social Introversion scale shared 58% of its variance with the combined Avoidant and Histrionic scales of the MCMI-III. Moreover, comparing 58% to the original R_c^2 value of .77 indicates that the simplification process resulted in a modest loss of shared variance between the two multivariate composites.

The coefficients for the second pair of functions were examined, and salient coefficients revealed primarily high levels on schizophrenia, hypomania, depressive, antisocial, schizotypal, and paranoid scales, with low avoidant and negativistic (passive-aggressive) personality characteristics. For the second canonical function the simplified composite was equal to: (1)(Schizophrenia) + (1)(Hypomania) = (-1)(Avoidant) + (1)(Depressive) + (1)(Antisocial) + (1)(Schizotypal) + (1)(Paranoid) + (-1)(negativistic) or (-1)(Schizophrenia) + (-1)(Hypomania) = (1)(Avoidant) + (-1)(Depressive) + (-1)(Antisocial) + (-1)(Schizotypal) + (-1)(Paranoid) + (1)(negativistic). This composite may represent experiences of affective dysregulation or Millon's "insipid" and "timorous" subtypes of schizotypal personality disorder. The squared canonical correlation coefficient (R_c^2) between the two simplified composites on the second canonical function was large and statistically significant, R_c^2 (98) = .41, $p < .001$, indicating that the MMPI-2 Schizophrenia and Hypomania scales shared 41% of their variance with the combined Depressive, Antisocial, Schizotypal, and Paranoid scales of the MCMI-III. Again, this shared variance compared favorably to the value for the original discriminant functions (.49) and demonstrated a modest loss in shared variance between the two multivariate composites as a result of the simplification process.

Table 2 presents the correlation matrix between MMPI-2 scales. Numerous scales were found to be significantly correlated with one another, with the strongest relationship found between the Schizophrenia and Paranoia scales (.73). The correlation matrix between MCMI-III scales (Table 3) also demonstrates a high degree of overlap, with the highest correlation found between the Negativistic and Borderline scales (.78). Correlations between the two measures can be found in Table 4.

Discussion

The MMPI-2 and the MCMI-III are the two most widely administered self-report measures of personality; however, no studies in the literature have yet examined the multivariate linear relationship between the two multidimensional scales. The majority of previous studies have focused on the bivariate correlations between the two current versions of these inventories and/or their predecessors (Blais, Benedict, & Norman, 1995; McCann,

1989; Rossi, Hauben, Van Den Brande, & Sloore, 2003; Schoenberg, Dorr, Don, & Burke, 2004; Wise, 1996). Comparing the two inventories using bivariate correlations erroneously assumes that each individual's score on one of the clinical indices is independent of how the person responded on the other indices. Multivariate analyses enable personality researchers to examine the patterns of scoring without removing their subjects from the context of their other scores. Results of the present study support the strong relationship and overlap between the MMPI-2 and the MCMI-III. Omnibus canonical analyses indicated that the two personality inventories shared more than 97% of variance in this clinically elevated sample. This also suggests that while the MCMI-III is intended for use strictly with clinical populations, the substantial shared variance with the MMPI-2 suggests that any potential biases are not present in the current sample of college students. In addition to testing the overall strength of the relationship between the MMPI-2 and the MCMI-III, discriminant functions were identified linking the relevant indices from the two inventories. These multivariate linkages help further the understanding of how certain personality dimensions cluster together. The canonical analysis identified two distinct linkages across all 24 of the indices between both measures. To increase conceptual meaning, the first canonical function was reduced by generating a simplified composite from the largest observed absolute value regression weights. This simplified composite accounted for 58% of the shared variance between the MMPI-2 and the MCMI-III on the first discriminant function. Conceptually, this discriminant function indicates that individuals who endorsed low levels of social introversion on the MMPI-2 also endorsed low and high levels of avoidance and hysteria on the MCMI-III, respectively. This presentation is consistent with Jung's belief that the neurotic breakdown of the extravert results most frequently in hysteria (Jung, 1921). Similarly, Eysenck's circumplex model of personality, which demarcates people along two dichotomous dimensions (stable/unstable and extraversion/introversion), reserves the term "hysteric" to refer to the neurotic pole of extraversion (Eysenck, 1970). Finally, Millon also conceptualizes each personality dimension as having multiple subtypes and this simplified composite encapsulates the "theatrical" presentation of histrionic personality disorder (Millon & Bloom, 2008).

Another simplified composite was constructed, helping to explain 41% of the shared variance between the MMPI-2 and the MCMI-III on the second discriminant function. Although the regression weights were not as distinct on the second discriminant function, a strong pattern emerged which is best characterized by Millon's "insipid" and "timorous" subtypes of schizotypal personality disorder. Individuals who have scores congruent with the insipid pattern display more melancholic and schizoid features, as well as bizarre patterns of thinking. The timorous subtype is characterized by active avoidance of negative affect and negativistic apprehensiveness (Freeman, Pretzer, Fleming, & Simon, 2004; Millon & Bloom, 2008). In addition, blunted affect has been viewed as a form of affect dysregulation. In particular, those with schizophrenia spectrum tendencies often suppress emotional experiences, have exaggerated negative emotional experiences or display emotions incongruent with their reported internal experiences (Cohen, Najolia, Brown, & Minor, 2011; Henry et al., 2007; Henry, Rendell, Green, McDonald, & O'Donell, 2008; Henry et al., 2009). It is not necessarily surprising to find elevations associated with affect dysregulation on the MMPI-2 to be correlated to increases in the depressive features of the MCMI-III. The association with lower score on the negativistic and avoidant scale may suggest that these more active approaches are not consisted with the other scales represented in this function (Strack, 2008). This pattern of scoring is also consistent with the unstable quadrants described in Eysenck's circumplex model (Eysenck, 1970).

Clinical implications may be extrapolated from the identification of significant shared variance between these two self-report measures of personality. Particularly, it seems unnecessary to give both the MCMI-III and MMPI-2 when evaluating an individual from a clinical population given the constructs significantly overlap. The clinician's and client's time may be best spent utilizing either the MCMI-III or the MMPI-2 and a structured interview for personality assessment. This multi-trait multi-method strategy would provide better confidence in the diagnoses by increasing convergent and discriminant validity in the personality assessment.

Although the results of the current study are statistically and clinically significant, there were still multiple limitations. We attempted to replicate our findings by identifying in the extant literature a complete correlation matrix between the MMPI-2 and the MCMI-III; however, all of the studies that were located simply reported the correlations between the measures rather than within the measures as well. The authors of these relevant studies were also contacted in an effort to gather the missing data, but to no avail. As a result, we are including the full correlation matrix (Table 2, 3, & 4) which was observed in our clinical sample with the hope that other researchers will either replicate or challenge our findings. Another limitation involves the size of our clinical sample. Multivariate analyses require a sufficient number of observations per variable to avoid "overfitting" the data. To increase the external validity and overall strength of the findings it is ideal to have at least 10 observations per variable and we obtained approximately five observations per variable (Hair, Tatham, Anderson, & Black, 1998). Although our limited sample size is certainly an important limitation to consider, the literature suggests that this requirement can be relaxed somewhat when utilizing highly reliable variables (e.g., Hair, Black, Babin, Anderson, &

Tatham, 2006). Given the high reliability of both the MMPI-2 and MCMI-III, our findings are thought to be a meaningful addition to the current literature. However, future studies are warranted to replicate our findings with larger sample sizes.

The current study is the first in the literature to examine the interdependence between the MMPI-2 and the MCMI-III. Additional research focusing on multivariate relationships between leading personality measures is strongly encouraged. Researchers with theoretical orientations aligning with Gordon Allport's work may be particularly well suited to such investigations, given his "morphogenic" perspective of personality. More specifically, Allport postulated that the organization and structure of each individual's personality is unique; however, the structure itself is still composed of traits shared by everyone (Allport, 1961). By examining the measures multivariately, we were able to identify emerging patterns of scores that help us better define how certain personality characteristics cluster together while taking into account the influence of other traits and dimensions on each individual's score. Robins & Tracy (2003) noted:

> Instead, personality researchers should focus on the total constellation of traits that define each person, and the way these traits work together as a dynamic, integrated system….More specifically, the [person-centered] approach seeks to identify regions in multivariate space where individuals are densely clustered, implying the existence of homogenous subgroups. Individuals occupying the same cluster are assumed to have a shared etiology and similar personality dynamics. (p. 111)

Finally, multivariate analyses will enable researchers to better deconstruct and refine these measures to improve their clinical utility for identifying salient personality configurations.

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Table 1

Canonical Solution of MMPI-2 Predicting MCMI-III for Functions 1 and 2

	Function 1		*Function 2*	
Variable	*Coef*	r_s	*Coef*	r_s
MMPI-2 Clinical Scales				
1- Hypochondriasis	.09	.25	-.20	.28
2- Depression	.11	.71	.09	.22
3- Hysteria	-.23	.09	.19	.42
4- Psychopathic Deviate	.17	.36	.05	.46
5- Masculinity-Femininity	.06	.02	.12	.35
6- Paranoia	.24	.56	.05	.43
7- Psychasthenia	.19	.75	-.11	.15
8- Schizophrenia	-.20	.47	.57	.66
9- Hypomania	.19	-.11	.57	.80
0- Social Introversion	.76	.92	-.22	-.26
MCMI-III Personality Disorder Scales				
1- Schizoid	-.09	.61	-.25	.11
2A- Avoidant	.37	.92	-.69	-.16
2B- Depressive	.08	.75	.46	.25
3- Dependent	.10	.67	-.23	.12
4- Histrionic	-.34	-.87	-.24	.06
5- Narcissistic	-.14	-.77	.34	.22
6A- Antisocial	-.03	.16	.53	.59
6B- Sadistic (Aggressive)	.08	.35	-.35	.26
7- Compulsive	.14	-.14	-.02	-.44
8A- Negativisitic (Passive-Aggressive)	.01	.64	-.46	.27
8B- Masochistic (Self-Defeating)	-.02	.73	.36	.27

S - Schizotypal	.02	.61	.57	.52
C- Borderline	.18	.61	.10	.45
P - Paranoid	.13	.57	.54	.42

Notes. Coef = standardized canonical function coefficient; r_s = structure coefficient

Table 2

Correlations Between MMPI-2 Scales (n = 98)

	Hs	D	Hy	Pd	Mf	Pa	Pt	Sc	Ma	Si
Hs	1.00	.51*	.72*	.28*	.10	.41*	.42*	.57*	.02	.20
D		1.00	.52*	.43*	.06	.53*	.63*	.55*	-.05	.62*
Hy			1.00	.43*	.22*	.41*	.33*	.51*	.02	.07
Pd				1.00	.18	.43*	.45*	.60*	.08	.17
Mf					1.00	.01	-.07	.11	.18	-.06
Pa						1.00	.58*	.73*	.08	.36*
Pt							1.00	.64*	-.09	.61*
Sc								1.00	.20	.32*
Ma									1.00	-.37*
Si										1.00

Note. * indicates significance at $p < .05$. MMPI-2 Scales: Hs = Hypochondriasis, D = Depression, Hy = Hysteria, Pd = Psychopathic-Deviate, Mf = Masculinity-Femininity, Pa = Paranoia, Pt = Psychasthenia, Sc = Schizophrenia, Ma = Hypomania, and Si = Social Introversion.

Table 3

Correlations Between MCMI-III Scales (n = 98)

	1	2A	2B	3	4	5	6A	6B	7	8A	8B	S	C	P
1	1.00	.58*	.45*	.34*	-.71*	-.40*	.23*	.24*	-.14	.35*	.55*	.45*	.38*	.41*
2A		1.00	.63*	.53*	-.84*	-.68*	.07	.18	-.09	.47*	.65*	.50*	.38*	.40*
2B			1.00	.59*	-.54*	-.59*	.24*	.34*	-.28*	.63*	.70*	.51*	.63*	.41*
3				1.00	-.44*	-.56*	.20*	.25*	-.30*	.58*	.66*	.52*	.56*	.47*
4					1.00	.63*	-.05	-.12	.09	-.37*	-.53*	-.51*	-.37*	-.35*
5						1.00	-.02	-.15	.16	-.41*	-.58*	-.41*	-.41*	-.25*
6A							1.00	.59*	-.61*	.46*	.26*	.32*	.60*	.32*
6B								1.00	-.37*	.59*	.33*	.35*	.62*	.52*
7									1.00	-.47*	-.27*	-.38*	-.54*	-.27*
8A										1.00	.63*	.52*	.78*	.71*
8B											1.00	.54*	.63*	.53*
S												1.00	.54*	.47*
C													1.00	.56*
P														1.00

Note. * indicates significance at $p < .05$. MCMI-III Scales: 1 = Schizoid, 2A = Avoidant, 2B = Depressive, 3 = Dependent, 4 = Histrionic, 5 = Narcissistic, 6A = Antisocial, 6B = Sadistic, 7 = Compulsive, 8A = Negativistic, 8B = Masochistic, S = Schizotypal, C = Borderline, and P = Paranoid.

Table 4

Correlations Between MMPI-2 and MCMI-III Scales (n = 98)

	Hs	D	Hy	Pd	Mf	Pa	Pt	Sc	Ma	Si
1	.16	.37*	.04	.38*	.02	.35*	.48*	.40*	-.08	.46*
2A	.16	.55*	.05	.30*	.03	.39*	.59*	.30*	-.20	.77*
2B	.11	.57*	.12	.33*	.09	.43*	.58*	.35*	.09	.51*
3	.12	.39*	.04	.10	.06	.31*	.52*	.33*	.04	.54*
4	-.21*	-.49*	-.06	-.36*	.08	-.49*	-.58*	-.39*	.17	-.70*
5	-.14	-.50*	-.08	-.21*	.13	-.35*	-.50*	-.24*	.24*	-.67*
6A	.12	.21*	.12	.37*	.21*	.22*	.19	.30*	.32*	-.04
6B	-.01	.27*	-.06	.11	-.01	.22*	.22*	.21*	.17	.21*
7	-.07	-.26*	-.22*	-.28*	.08	-.31*	-.32*	-.33*	-.14	.00
8A	.16	.52*	.13	.25*	.07	.36*	.51*	.38*	.09	.46*
8B	.21*	.51*	.19	.29*	.14	.41*	.53*	.45*	.04	.58*
S	.19	.47*	.21*	.33*	.03	.50*	.43*	.54*	.19	.43*
C	.24*	.51*	.21*	.33*	.11	.48*	.51*	.48*	.16	.39*
P	.22*	.41*	.12	.21*	.11	.32*	.41*	.44*	.22*	.41*

Note. * indicates significance at $p < .05$. MMPI-2 Scales: Hs = Hypochondriasis, D = Depression, Hy = Hysteria, Pd = Psychopathic-Deviate, Mf = Masculinity-Femininity, Pa = Paranoia, Pt = Psychasthenia, Sc = Schizophrenia, Ma = Hypomania, and Si = Social Introversion. MCMI-III Scales: 1 = Schizoid, 2A = Avoidant, 2B = Depressive, 3 = Dependent, 4 = Histrionic, 5 = Narcissistic, 6A = Antisocial, 6B = Sadistic, 7 = Compulsive, 8A = Negativistic, 8B = Masochistic, S = Schizotypal, C = Borderline, and P = Paranoid.